Amendments to the Claims

In compliance with the Revised Amendment Format, a complete listing of claims is provided herein.

1. (Previously Presented) A total-reflection x-ray fluorescence apparatus comprising:

an x-ray source for providing x-rays;

a doubly-curved x-ray optic for diffracting and focusing the x-rays provided by the x-ray source;

a surface onto which at least some of the diffracted and focused x-rays are directed; and

an x-ray detector for detecting resultant x-ray fluorescence emitted by any foreign matter present on the surface.

2. (Canceled)

3. (Previously Presented) An apparatus as recited in claim 1 wherein the doubly-curved x-ray optic is a crystal or multi-layer x-ray optic.

4. (Original) An apparatus as recited in claim 1 wherein the doubly-curved x-ray optic has one or more atomic planes.

5. (Original) An apparatus as recited in claim 4 wherein the atomic planes are curved to form a toroidal, ellipsoidal, spherical, parabolic, or hyperbolic shape.

6. (Previously Presented) An apparatus as recited in claim 1, further comprising one or more apertures for limiting a convergent angle onto the surface of the diffracted x-rays, wherein the convergent angle comprises the angle subtending the upper and lower extents of the diffracted x-rays.

7. (Canceled)

8. (Original) An apparatus as recited in claim 6, wherein the one or more apertures comprise an elongated slot.

9. (Original) An apparatus as recited in claim 6, wherein the one or more apertures produce a convergent angle for the diffracted x-rays which is less than the critical angle for the total reflection of the x-rays from the surface for the wavelength of the x-rays.

10. (Original) An apparatus as recited in claim 1, wherein the doubly-curved x-ray optic employs Bragg's law in diffracting the x-rays.

11. (Original) An apparatus as recited in claim 1, further comprising an analyzer for analyzing the x-ray fluorescence detected by the detector.

12. (Original) An apparatus as recited in claim 1, wherein the surface is an optical reflection surface.

13. (Original) An apparatus as recited in claim 1, wherein the surface is a surface of a semi-conductor wafer.

14. (Previously Presented) A total-reflection x-ray fluorescence apparatus comprising:

an x-ray source for providing x-rays;

a doubly-curved x-ray optic for diffracting and focusing the x-rays provided by the x-ray source;

a surface onto which at least some of the diffracted and focused x-rays are directed;

an x-ray detector for detecting resulting x-ray fluorescence emitted by any foreign matter present on the surface; and

wherein the locations of the doubly-curved x-ray optic, x-ray source, and point of impingement upon the surface define an optical circle of radius R wherein the doubly-curved x-ray optic has an optic surface of radius 2R and one or more atomic planes essentially parallel with the optic surface.

15. (Original) An apparatus as in claim 14, wherein the doubly-curved x-ray optic provides one of symmetric or asymmetric Bragg diffraction.

16. (Original) An apparatus as recited in claim 14, wherein the atomic planes are curved to form a toroidal, ellipsoidal, spherical, parabolic, or hyperbolic shape.

17. (Original) An apparatus as in claim 14, wherein the doubly-curved x-ray optic has a transverse plane perpendicular to the optic circle wherein in the transverse plane the atomic planes are circular.

18. (Previously Presented) A method for detecting presence of foreign matter on a surface by total x-ray diffraction using a doubly-curved x-ray optic, comprising:

providing a source of x-rays;

diffracting and focusing at least some of the x-rays using a doubly-curved x-ray optic and impinging the diffracted and focused x-rays upon the surface; and

detecting fluorescent x-rays responsive to the impingement from any foreign matter present on the surface.

19-20. (Canceled)

21. (Original) A method as recited in claim 18, further comprising exciting foreign matter present on the surface with the diffracted x-rays so that the foreign matter emits the fluorescent x-rays.

22. (Previously Presented) A method as recited in claim 18, further comprising passing the diffracted x-rays through at least one aperture to limit the convergent angle onto the

surface of the diffracted x-rays, wherein the convergent angle comprises the angle subtending the upper and lower extents of the diffracted x-rays.

23. (Canceled)

24. (Original) A method as recited in claim 18, further comprising analyzing the detected x-rays to determine the nature of the foreign matter.

25-40. (Canceled)

41. (Previously Presented) A total-reflection x-ray fluorescence apparatus comprising:

an x-ray source for providing x-rays;

a doubly-curved x-ray optic for diffracting and focusing the x-rays provided by the x-ray source;

a surface onto which at least some of the diffracted and focused x-rays are directed;

an x-ray detector for detecting resulting x-ray fluorescence emitted by any foreign matter present on the surface; and;

wherein the x-ray source and the point of impingement upon the surface define an optic circle of radius R, and wherein the doubly-curved x-ray optic comprises a surface and a plurality of atomic planes of radius R_P which intersect the surface at an angle α; and wherein the radius of the atomic planes R_P of the doubly-curved x-ray optic is defined by the equation $R_P = 2R \cos \alpha$.

42. (Previously Presented) An apparatus as recited in claim 41, wherein the angle α is greater than 0° and less than 90°.

43. (Previously Presented) An apparatus as recited in claim 42, wherein the angle α is greater than 0° and less than 20°.

44. (Previously Presented) An apparatus as recited in claim 41, wherein the doubly-curved x-ray optic is curved to a toroidal, ellipsoidal, spherical, parabolic, or hyperbolic shape.

45. (Previously Presented) An apparatus as recited in claim 41, wherein the doubly-curved x-ray optic exhibits asymmetric Bragg diffraction.

46. (Previously Presented) An apparatus as recited in claim 41, wherein the doubly-curved x-ray optic also focuses the x-rays on to the surface.

47. (Previously Presented) An apparatus as in claim 46, wherein the doubly-curved x-ray optic focuses x-rays to a footprint on the surface and wherein the footprint comprises a largest dimension less than 1 mm.

48. (Previously Presented) An apparatus as in claim 47, wherein the doubly-curved x-ray optic focuses x-rays to a footprint on the surface wherein the footprint comprises a largest dimension less than 500 microns.

49. (Previously Presented) An apparatus as recited in claim 6, wherein the one or more apertures are positioned after the x-ray optic.

50. (Previously Presented) A method as recited in claim 22, wherein the passing through at least one aperture is practiced after the x-ray optic.

51. (Currently Amended) ~~The apparatus as recited in claim 1,~~ A total-reflection x-ray fluorescence apparatus comprising:

an x-ray source for providing x-rays;

a doubly-curved x-ray optic for diffracting and focusing the x-rays provided by the x-ray source;

a surface onto which at least some of the diffracted and focused x-rays are directed; and

an x-ray detector for detecting resultant x-ray fluorescence emitted by any foreign matter present on the surface;

wherein the doubly-curved x-ray optic comprises:

a backing plate having a supporting surface;

an adhesive layer disposed above said supporting surface of said backing plate, said adhesive layer having a minimum thickness x; and

an optical layer disposed above said adhesive layer, said optical layer comprising an optical surface, said optical surface of said optical layer having a desired curvature, and said optical layer having a thickness y, wherein x>y.

52. (Previously Presented) The apparatus as recited in claim 51, wherein said supporting surface of said backing plate has a curvature, said curvature of said supporting surface being different than said curvature of said optical surface of said optical layer.

53. (Previously Presented) The apparatus as recited in claim 51, wherein said adhesive comprises an epoxy material, and wherein said optically curved element further comprises a protective layer surrounding an edge of said optical layer such that said adhesive is disposed between said optical layer, with said protective layer surrounding said edge thereof, and said supporting surface of said backing plate.

54. (Previously Presented) The apparatus as recited in claim 51, wherein said minimum thickness x of said adhesive layer is greater than or equal to 20 μm; and said thickness y of said flexible layer is greater than or equal to 5 μm.

55. (Previously Presented) The apparatus as recited in claim 51, wherein said optical layer comprises a crystal.

56. (Previously Presented) The apparatus as recited in claim 55, wherein said adhesive layer is an epoxy, and wherein: x is between 0.1 mm and 1 mm and y is between 10 μm and 50 μm.

57. (Previously Presented) The apparatus as recited in claim 14, wherein the doubly-curved x-ray optic comprises:

a backing plate having a supporting surface;

an adhesive layer disposed above said supporting surface of said backing plate, said adhesive layer having a minimum thickness x; and

an optical layer disposed above said adhesive layer, said optical layer comprising an optical surface, said optical surface of said optical layer having a desired curvature, and said optical layer having a thickness y, wherein x>y.

58. (Currently Amended) ~~The method as recited in claim 18,~~ A method for detecting presence of foreign matter on a surface by total x-ray diffraction using a doubly-curved x-ray optic, comprising:

providing a source of x-rays;

diffracting and focusing at least some of the x-rays using a doubly-curved x-ray optic and impinging the diffracted and focused x-rays upon the surface; and

detecting fluorescent x-rays responsive to the impingement from any foreign matter present on the surface;

wherein the doubly-curved x-ray optic comprises:

a backing plate having a supporting surface;

an adhesive layer disposed above said supporting surface of said backing plate, said adhesive layer having a minimum thickness x; and

an optical layer disposed above said adhesive layer, said optical layer comprising an optical surface, said optical surface of said optical layer having a desired curvature, and said optical layer having a thickness y, wherein x>y.

59. (Previously Presented) The method as recited in claim 58, wherein said supporting surface of said backing plate has a curvature, said curvature of said supporting surface being different than said curvature of said optical surface of said optical layer.

60. (Previously Presented) The method as recited in claim 58, wherein said adhesive comprises an epoxy material, and wherein said optically curved element further comprises a protective layer surrounding an edge of said optical layer such that said adhesive is disposed between said optical layer, with said protective layer surrounding said edge thereof, and said supporting surface of said backing plate.

61. (Previously Presented) The method as recited in claim 58, wherein said minimum thickness x of said adhesive layer is greater than or equal to 20 μm; and said thickness y of said flexible layer is greater than or equal to 5 μm.

62. (Previously Presented) The method as recited in claim 58, wherein said optical layer comprises a crystal.

63. (Previously Presented) The method as recited in claim 62, wherein said adhesive layer is an epoxy, and wherein: x is between 0.1 mm and 1 mm and y is between 10 μm and 50 μm.

64. (Previously Presented) The apparatus as recited in claim 41, wherein the doubly-curved x-ray optic comprises:

a backing plate having a supporting surface;

an adhesive layer disposed above said supporting surface of said backing plate, said adhesive layer having a minimum thickness x; and

an optical layer disposed above said adhesive layer, said optical layer comprising an optical surface, said optical surface of said optical layer having a desired curvature, and said optical layer having a thickness y, wherein x>y.